Final Report
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Creating New Markets for Vegetables Through the Production of Dehydrated Vegetable Powders

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North Dakota Department of Agriculture
600 Blvd. Ave., Dept. 602
Bismarck, North Dakota 58505-0020
L. Roger Johnson, Commissioner
Chuck Fleming, Marketing Director

Heart of the Valley, LLC
30 Main Street East
Portland, North Dakota 58257
Kim Nesvig
David Speare
Neil Doty

Mid-America Consultants International
P.O. Box 806
Fargo, North Dakota 58107
William C. Nelson
Hugh Dufner

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Background and Issues

North Dakota farmers are confronted with steadily narrowing margins on the region's major cash crops. Agricultural diversification into vegetable crops may represent a means of increasing net farm incomes, sustaining both small farms and rural communities.

A surprisingly wide array of vegetables of excellent quality and outstanding flavor can be produced in the climate and soils of North Dakota's Red River Valley. Locally grown vegetables, when in season, are widely consumed and highly appreciated. Unfortunately, the market window for northern-grown fresh vegetables is very limited due to product perishability and a short frost-free growing season. The limited market window for perishable fresh vegetables has discouraged large-scale production in North Dakota. The absence of a large urban center, combined with weather constraints, has discouraged the development of farmers' markets and other outlets for fresh produce.

Vegetable production has become an important part of the agricultural economy in other northern states. For example, vegetable canning and freezing plants have long been established in southern Minnesota and Wisconsin. In contrast, there few processing plants in North Dakota and these are dedicated to processing less perishable items such as potatoes. Relatively small acreages of carrots and onions are currently grown commercially in the state. These are stored for later consumption and processing out of state.

Despite the climatic limitations and the absence of established markets, North Dakota appears to have several assets which could contribute to the development of a vegetable industry. First, an edible bean dehydration facility has been constructed Portland, ND. Heart of the Valley Cooperative, a group representing more than 400 area farmers, is the majority owner of the new plant. This plant could utilize part of its capacity to the manufacture of vegetable powders from northern-grown vegetables. If sufficient quantities of vegetables can be obtained at a competitive price, and if the plant can process these vegetables in a cost effective manner, the plant could provide a new market for locally grown vegetables.

Production of dehydrated vegetable powders could permit expanded production of vegetables by providing additional market opportunities for farmers. The more perishable products would be sold immediately to the fresh produce market or partially processed into a storable puree; the less perishable products would be temporarily stored and then dehydrated into shelf-stable vegetable powders, which could be marketed over an extended period of time.

Vegetable powders are used in the manufacture of a variety of prepared food products. For example, dehydrated sweet potato and pumpkin powder are used in bakery mixes, adding color, flavor and moistness to mixes. These products find their way to the consumer through commercial bakeries, institutional feeders and at retail through a variety of dry-mix products.

Several food processing companies in North Dakota could represent potential markets for vegetable powders. The North Dakota State Mill, located in Grand Forks, produces spring wheat flour and packages a line of retail bread machine mixes. Roman Meal Milling Company of Fargo, ND, produces over 100 different multi-grain bases for the bakery industry. Top Taste, Inc., of Finley, ND is a national manufacturer of over 400 products. Top Taste, Inc. produces under its own brands and several co-packing arrangements.

An even larger regional potential market for vegetable powders exists about 250 miles to the southeast in the Minneapolis-St. Paul metropolitan area. The Twin Cities are home to some of the nation's largest food processing companies.

Eastern North Dakota has a surplus of temperature-controlled storage facilities due to the movement of potato production toward irrigated areas of central North Dakota and central Minnesota. Vacant potato warehouses can be rented or purchased at bargain prices, and can easily be adapted to store other lesser perishable vegetable crops.

In summary, North Dakota has the agronomic potential to produce high quality vegetable crops, but the short growing season, distance from urban markets and lack of vegetable processing facilities have discouraged the development of a commercial vegetable industry in the state. The North Dakota Department of Agriculture, working in cooperation with Mid-America Consultants International (MACI) and Heart of the Valley (HOV) Cooperative evaluated the economic feasibility of producing several vegetable crops for processing in the Cooperative's edible bean dehydration facility in located in Portland, North Dakota. A successful project will result in the creation of new crop alternatives for the 400 members of the Cooperative and will create new employment opportunities in Portland, ND, a rural community of 600.

Project Approach

Goals and Objectives

The purpose of this study is to determine the feasibility of producing vegetable powders and related value-added products from selected North Dakota grown vegetables. To accomplish this objective, the investigators:

- Evaluated the economic feasibility of producing several vegetable crops for processing in a drum drying facility in eastern ND
- Developed preliminary processing procedures and cost estimates comparing the use of locally-grown vegetables against commercially available purees in the production of dehydrated vegetable powders
- Evaluated the market potential and trends for a variety of vegetable powders and associated value added products produced at in a North Dakota-based dehydration facility.

Work Plan

The work plan consisted of three distinct areas of research involving:

1. **Crop Production**
2. **Processing Technology & Costs**
3. **Market Feasibility**

The project approached the problem from three levels. Since vegetable production is not well established in the region, the study sought to project commercial crop production costs for vegetables that could be grown in the region. The second level of analysis considered the cost of producing purees and powders from locally grown vegetables. The cost analysis included storage, handling and processing considerations. The processing cost projections were then used in a comparative analysis with commercial sources of vegetable puree. The third level of analysis focused on market opportunities. Without exception, the vegetable purees and powders identified for this project represent very specialized, niche market opportunities. As a result, the market potential for each product was evaluated through the trade knowledge of brokers, food technologists, and buyers of specialty food ingredients.

Results & Conclusions

Results

Crop Production & Input Supply

Local vegetable growers were contacted to determine the types and varieties of crops currently being grown and marketed from the area. The specialty vegetable crops currently being grown nearby include pumpkins (ornamental and for seed), squash, several varieties of melons, organic potatoes, tomatoes and sweet corn. Most of these go to the local fresh market, with the exception of the pumpkin seed grower. As expected, none of the area producers have any capacity to process and store product for later processing into puree or powder.

The work has focused on research into the production opportunities of crops deemed to have high potential for dehydration including sweet potatoes, sweet corn, red beets and squash/pumpkin. A review of literature on sweet potatoes was completed, as well as small field plots of the above items grown organically with a view toward both gaining production experience as well as obtaining sample amounts of dehydrated product to stimulate market interest. The experimental sweet potato and squash/pumpkin plots were devastated by an abnormal August frost, but variety knowledge and production experience was gained. The early sweet corn was not processed due to lack of equipment and the cost of organic certification. Red beets showed no significant production problems and were stored for later dehydration. Cost estimates of obtaining organic certification of the HOV plant were obtained from two certifying organizations; the decision to certify was postponed till more is learned about the demand for organic products.

Red Beets: Beets are a source of intense natural red colorant which might be used in the natural foods industry, and beets are a recommended ingredient in some weight watchers diets.

Red beets were identified as having high production feasibility in the Red River Valley of North Dakota. They can be planted and cultivated using existing sugar beet equipment and can be harvested with carrot lifting equipment which exists in the Valley. Like the larger rooted sugar beet, red beets thrive well on the potassium-rich, heavy loam soils of the Red River Valley, and appear to have few production problems.

Because red beet roots are smaller in size the sugar beets, harvest could perhaps best be accomplished with a carrot/red beet harvester which lifts them by the tops prior to severing the stems from the roots. Lifting beets by the tops is a viable alternative until the tops either die down or become weakened, or until they become limp after heavy frost. For late harvest, beet tops can be flailed and harvested with a potato harvester; or the beets roots (if they are large) can be crowned with a sugar beet knifer and the lifted with modified sugar beet harvest equipment. Yields of red beets would be less than sugar beets. Knott's Handbook for Vegetable Growers cites 260 cwt (13 ton) per acre as an average U.S. yield for processing beets, and 300 (15 ton) cwt per acre as a good yield.

Beets could be stored after harvest in potato storage facilities which are currently in excess supply in the Red River Valley. Red beets stored a 32 degrees produce about twice as much heat (2,700 BTU/ton/day) as do potatoes stored at 40 degrees (600-1,900 BTU/ton/day)(Lorenz). Without high humidity, they loose their moisture and become soft more readily than potatoes. Beets freeze at 30.3 degrees, store best at 32 degrees with 90-95% humidity, and have an approximate storage life of 3-5 months (Lorenz).

If red beets were to be dehydrated on a very large scale, there is no apparent reason why they could not be stored outdoors on piles and frozen in a manner similar to sugar beets. Some natural air dehydration would take place, and once frozen, root decay, respiration, and internal enzymatic action would be greatly reduced. The elimination of indoor storage costs would significantly reduce the raw product cost.

Two varieties of red beets were compared as they were prepared for processing and dehydration; red ruby grown, organically from Hugh's Gardens, and Detroit dark red from HOV employee John Chandler. There was a marked difference in the quality of these two beets. The red ruby beets, although smaller due to lack of rain, were a much smoother and more regular shaped beet with a much finer texture. Visual analysis of the product suggests that red ruby would yield a much higher percentage of vibrant red colorant. It would work as a multi-purpose beet for fresh market, canning, freezing and dehydration. Prior discussion of beet varieties with Minnesota Dehydrated Vegetable confirms that there are significant differences among beet varieties with respect to color.

Sweet potato: Preliminary analysis of this product by HOV personnel suggested good profit margins for dehydrated sweet potato. An analysis of production possibilities suggested that sweet potato production for commercial use is not very feasible in the Upper Midwest due to our short growing season and cool weather. Sweet potatoes are grown primarily in Southern states. The top producing states are North Carolina, Louisiana, Alabama & Mississippi. California would be the major source for organic sweet potato (Labonte).

Although large scale, commercial sweet potato production in this region seems unlikely due to the crop's sensitivity to low temperatures, small-scale production may be feasible, particularly for organic sweet potatoes. Local organic production on a smaller scale may be feasible. Our earlier report noted that some organic sweet potatoes are grown in La Crosse, WI. Production of a higher value organic version of sweet potato powder may provide an alternative use for organic sweet potatoes that are not deemed suitable for the fresh market. Production of organic sweet potatoes in this region offers the advantage of relative isolation from pests and diseases that affect the crop in traditional growing areas.

Sweet potatoes are a high value, labor-intensive crop with the cost of production ranging in the "thousands of dollars per acre" level (Labonte). They are grown from stems which are mechanically transplanted into rows on raised beds with ample space between beds. They are normally dug mechanically in August, September and October. Because the tubers are very sensitive to bruise, they are hand picked off the harvester, classified, and

placed into bins as they are dug in the field; and then transported in bins to warehouses for storage. They are ideally stored at a temperature of around 58-60 degrees Fahrenheit with relative humidity around 85%. There are sweet potatoes in storage during practically all 12 months of the year (Fonteneau).

In response to this, the investigators explored alternatives for securing sweet potatoes through established growers in traditional growing areas. Growers and distributors in sweet potato growing areas, Mississippi, Louisiana, and Texas, were contacted. The focus has been to identify cost effective alternatives to the No. 1 Grade sweet potatoes intended for the fresh market. Like any crop, the farm price for sweet potatoes fluctuates with supply and quality. Last year's average farm price for sweet potatoes was $14.50/cwt. Adding transportation costs to this price, the minimum price will be $22/cwt. The drying process yields about 1 pound of sweet potato powder per five pounds of raw sweet potato. Conversely, 10 cents saved in the cost of the raw product translates into a fifty-cent savings on the cost of the finished product.

After harvest, sweet potatoes are cured at 85 degrees F with 90 to 95 percent relative humidity (RH) for 4 to 7 days. After curing, the storage temperature is reduced 55 to 60 degrees F at 80 to 85 % RH. Properly cured sweet potatoes will keep satisfactorily for 4 to 7 months, while prolonged exposure to temperatures below 54 degrees F may cause discoloration of the flesh, internal breakdown, off-flavors and accelerated decay. The handling and storage required for sweet potatoes obviously adds to the end price.

Some canners require uncured "green" product which is high in starch, and will buy and process canner grade sweet potatoes at harvest time. The buyer must determine whether uncured "green" or cured "kill dried" product better suits his processing needs. If sweet potatoes are purchased at harvest for later use, they need be stored at recommended temperatures to permit sweetening and prevent product loss (Fonteneau). The price of "canners" is established by the sweet potato canning operations, and is typically between $6-$10 per Cwt. (Labonte). Canning operations have been paying $7.00 per cwt. for year 2005 crop. There is a wide variation in the quality of product which is offered for sale under the "canner" designation, so a buyer is well advised to visually inspect the product which he is acquiring prior to purchase (Fonteneau).

"Kill dried" or cured sweet potatoes of canner grade are typically available in large quantities after major holidays; especially Thanksgiving, Christmas/New Years, and Easter; after shippers have sorted them out of their number one grade product. If semi-truck quantities are desired, it may be necessary to make advance commitments with growers, and it may also be necessary to acquire canners from more than one packing shed to fill a truck (Fonteneau).

The purchase of culls or "canner" grade sweet potatoes is a good way of saving on raw product costs. Canners or cull sweet potatoes, which include irregularly shaped, undersized or oversized tubers, are available at roughly 50% of the price of field run sweet potatoes. The most recent price quote we received indicated a price of $8.00/cwt

or a delivered price of $15.00/cwt. This translates into a savings of between $7 - $10/cwt or from $0.35 to $0.50 per pound of finished product.

Transportation represents another opportunity for savings in the cost of product. A number of local and regional trucking companies presently have routes that terminate in sweet potato growing regions. By providing a back-haul for these truckers we can reduce the cost of transportation.

Pumpkin and Squash: These two items are so similar in their production and processing characteristics that they can be considered as one. Both pumpkin and squash grow profusely and are highly adapted to production in our region. The Mandan Indians cultivated them prior to the arrival of white settlers.

Pumpkins for seed are currently being produced on a large scale at Hatton ND by Steve Enger in association with Randy Pederson of Specialty Commodities, Inc of Fargo. The mechanical harvester, which is currently used to harvest pumpkin seed at Enger's farm, preserves only the seed. The harvester crushes the pumpkin into medium sized pieces, removes the seed, and drops the broken pieces of pumpkin flesh with hull unto the ground. The only economic value of the pumpkin is the seed itself. Around 100 acres of pumpkins for seed of numerous varieties were produced in year 2005.

Dr. Chiwon Lee, horticulturalist with NDSU Department of Plant Sciences, is providing technical assistance in the evaluation of cultivars and pumpkin seed quality. Dr. Lee has also been seeking to identify a dual purpose pumpkin with favorable characteristics for both seed production and dehydration. The variety Golden Delicious has abundant seed, is sweet, and has deep orange flesh & skin, characteristics which appear desirable for dual purpose utilization. A sample of dehydrated pumpkin powder from China obtained by Dr. Lee was considerably paler than that which could be derived from the deep orange colored flesh of Golden Delicious. HOV, unfortunately, does not have the equipment needed to produce a pumpkin slurry which is needed in order to dehydrate the product, nor is anyone else in our region set up to do this. The ideal process and source of equipment required to make the slurry are at this point unknown.

One major production area for pumpkins is around Peoria, Illinois at Princeville and Morton, where it is reported that some 80% of the nation's pumpkins for pie are produced on some 5,000 acres. The variety "Dickenson" is used for this production. The Dickenson variety is buff colored and is shaped like an elongated watermelon. This variety is preferred because pies made with it do not split when cooked. Irrigation during production is discouraged because it increases the product's water content and decreases the percent of pumpkin flesh (Voigt).

The process used to harvest and process the pumpkins is a rather simple one. The pumpkins at harvest time are windrowed with a v-plow. This separates the fruit from the vines, and puts the pumpkins in a line. The pumpkin fruits are then mechanically harvested into semi trucks which haul them to a Libby's processing plant. The semi trucks are driven unto ramps which hoist them up and empty their cargo into a pit. The

pumpkins do not need to be treated gently since they go directly from the field to the processing plant; so there is no chance for decay or spoilage. Thereafter the pumpkins are cooked whole and run through a mill which removes the seed and skin (Voigt). The product is cooked with hot water or steam as it moves through pipes from one place to another (Enger). The processing plant was formerly used to process other things, including green beans, but it now processes only pumpkins, 24 hours per day, seven days a week for three continuous months, after which time it remains idle for the balance of the year. The plant appears to be a pretty self-contained operation with little need of outside help (Voigt).

Onion: Onions are currently produced on a large scale in North Dakota. North Dakota growers in the Oakes area have been growing and shipping to the East a large sweet Spanish type of onion suitable for onion rings, and a company called Kidco Farms Processing, Inc. (701-327-4377) at Dawson, ND has been cutting and peeling them for use by the food service industry. Under good growing conditions, onions yield profusely. North Dakota irrigated onion yields are reported to be in the neighborhood of 350 cwt per acre with a projected market price of $5.80 per cwt. providing a gross income per acre of $2030. Direct costs per acre are estimated at $1135, fixed costs at $337, for a total cost of $1472, leaving a return to labor & management of $558/acre (based on a budget by Mike Liane, NDSU Extension Irrigation Agent). Yield for dry land grown onions is somewhat less. A 1993 NDSU study budgeted a marketable yield of 290 50 lb. cases (i.e., 145 cwt) per acre for dry land onion. Knots handbook cites average US yield of 310 cwt/acre and a good yield of 400cwt/acre. Under good growing conditions, onion yields are dramatic.

While onions can be grown competitively in our northern region, most onion varieties require at least 95 days to mature and they can be damaged by an early fall frost after they have been lifted for field drying. This problem can be partially solved by better quality storage facilities with good air systems and a source of heat to cure the onions in storage, rather than allowing them to lie exposed in the field for an extended period of time. Onions which have suffered light frosting of the outer scales (e.g., perhaps down to 29-30 degrees) will have a reduced storage life but could still be dehydrated. If the bulbs are seriously frosted (e.g. Below 28 degrees) with frost damage penetrating several layers of tissue, it would be best to keep them very cold and dehydrate them as soon as possible. Onions freeze at 30.6 degrees (Lorenz).

After onions have been well cured, the outer leaves of the bulbs will be very dry and the storage temperature should be gradually lowered to an ideal long term storage temperature of 32 degrees with relative humidity of 65-70%. With a good air system, well cured onions in this state can be stored for up to eight months (Lorenz). Less optimal storage conditions (particularly higher temperature or humidity) will significantly shorten the expected product storage life.

Since field curing of onions creates a risk factor, and because warehouse storage represents a significant cost factor, small amounts of onions might ideally be dehydrated right out of the field in an uncured state. This would reduce both production and storage risks and make the final product price more competitive.

Carrots: Carrots deserve careful attention because they are well adapted for production in our Northern Region, and can be very competitively grown. They are currently being produced on a large scale at the Steve Enger Farm at Hatton, ND and shipped to MDV of Fosston where they are peeled, sliced or diced and dehydrated as whole pieces. Puffed Carrot pieces is a specialty of MDV. Carrot powder can also be produced at the Fosston plant by grinding the dehydrated pieces. Enger reports yields in the 20 ton per acre range (similar to sugar beets), with a delivered price in the neighborhood of $70-80 per ton, as compared to $36.24/ton, the average 2004 price per ton for Red River Valley sugar beets (NDSU). Enger's yields are slightly above the "good yield" estimate of 350 cwt (17.5 tons) cited in Knott's Handbook, but less than some northern processing carrot yields reported to be in the 30 ton range.

Knott's Handbook states that carrots reach market maturity between 50-95 days (i.e. fresh market types). However large processing carrots require the entire growing season to reach maximum tonnage. An NDSU extension publication indicates that Danvers, a medium long (7 inch) processing variety used for dehydration, requires 120 days to develop tonnage and sugar content (Goltz). Carrots become sweeter in late fall as soil temperatures cool. Because carrot roots are underground, they are relatively protected from frost and can be harvested until late into the fall. Carrot root tops, if frosted, will not break down, but may darken in color and become soft. Carrots, like beets, can be lifted by the tops using a carrot/red beet harvester until such time in the fall when the tops are weakened by frost (at around 27 degrees). After the tops die or are weakened by frost, or if the tops are crowned or flailed, large processing type carrots can be lifted using sugar beet harvesters with modified digging wheels.

The storage requirement of carrots is very similar to red beets. They can be stored unwashed for a period 4-5 months at 32 degrees with a relative humidity of 90-95% (or preferably higher). Carrots, like beets, have a high rate of respiration. When stored at 32 degrees, carrots produce from 2100-4500 BTUs of heat per day, which is roughly three times the amount of heat produced by potatoes stored at 40 degrees (600-1,900 BTUs). Less than optimal storage conditions (particularly a higher temperature) will considerably shortening their storage life (Lorenz). Losses in storage can be from product dehydration and product breakdown. The presence of yellow aster disease in carrot roots increases product breakdown. Dr. Ken Hellevang of NDSU, widely recognized for his work in storage, recalls seeing carrot losses in storage as high as the 15% range, as compared to more common storage losses of around 7% in potatoes. Dr. Hellevang's scholarly report: "Bulk Carrot Storage Environmental Engineering" provides excellent information on carrot storage requirements.

As in the case of red beets, the cost of indoor storage becomes a significant percent of the overall cost of raw product. Although the matter would require further investigation, there is no immediately apparent reason why carrots could not be harvested in late fall and frozen with cold night air in outdoor piles prior to dehydration if the scale of production were sufficiently large to justify it. Since yields are similar, the cost of

producing carrots for dehydration would then be similar to the cost of producing sugar beets.

Horseradish: Horseradish is produced on a large scale in Illinois, and there is a large scale producer in Wisconsin in the LaCrosse/EuClair area (Voigt). Collinsville, Illinois has an annual horse radish festival and appears to be the center of production. Some 24 million lbs. of horseradish roots are ground and processed annually to make six million gallons of prepared horseradish *(www.horseradishfestival.com)*. Horseradish is used as a meet sauce by European descendents in the US. It is also used to produce what is called "Wasabi" a Japanese variety of horse radish commonly eaten by Asians (Voigt).

The bite and aroma of horseradish is almost absent until the root is ground. The ground root is mixed with distilled vinegar to stabilize the "heat" or volatile elements and maintain its flavor *(www.horseradishfestival.com)*

It appears that horseradish is best consumed fresh, and that dehydration would cause it to lose the flavor of its volatile elements. Dehydrated horseradish would probably not find market acceptance unless the aromatic flavor can be retained. Dehydrates Inc. expressed interest in a horseradish product but suggested the price should be less than $1.00 per lb.

White Corn: White corn for grits and other products presents another interesting opportunity for area growers. At present, all available varieties of white corn are grown at lower latitudes. However, North Dakota State University and several seed companies are working on earlier maturation varieties that could be ready for use in this region within 2-3 years. Local production of this specialty crop would reduce transportation costs, and thereby increase the competitiveness of the dehydration plant in the production quick and instant grits.

Sweet Corn: Sweet corn is seasonal favorite garden vegetable in the Upper Midwest. NDSU horticulturalist Chiwon Lee noted its exceptionally sweet flavor, which is probably attributable to our potassium rich soil and our cool summer nights. Limited amounts of sweet corn are currently being grown in the Red River Valley and surrounding region for home consumption and to satisfy fresh local markets. Sweet Corn is being grown on a large commercial scale in Southern Minnesota near Sleepy Eye where it is canned by Del Monte. Sweet corn is also being grown for a Lakeland Foods freezing plant at Brooten, Minnesota, southwest of Sauk Center.

While an excellent quality corn can be produced in the Red River Valley, harvesting and processing it at exactly the right time is crucial for achieving a high quality finished product. Sandy soils which permit irrigation and harvest on time might be required to obtain a reliable source of supply. The equipment required for harvesting and processing sweet corn it is also specialized. It appears that most dehydrated sweet corn is made from kernels that have been through an IQF (instant quick freeze) process. This process currently does not exist in the Red River Valley.

Given the harvesting and processing demands for sweet corn, it appears that HOV would be well advised to acquire IQF corn for dehydration from existing operations in Southern Minnesota.

Organic Potatoes & Vegetables: The production of certified organic potatoes in the Red River Valley area is currently oriented toward fresh market destinations. It appears at present that Hugh's Gardens of Halstad, MN may be the only certified organic potato packer operating in the Red River Valley during year 2006. Hugh's Gardens anticipates an intake of about 20,000 cwt of red, yellow and russet potatoes from four area growers producing on 160 acres with an average yield of 125 cwt per acre. Pack out of #1 grade product for fresh market is estimated at 80% percent, leaving a 20% balance (i.e., 4000 cwt) of off grade product of all varieties for alternative destinations. This product becomes available over an eight month marketing period as potatoes are washed, starting mid-October and ending around June 1st.With advanced planning, Hugh's Gardens could provide off-grade certified organic potatoes, properly graded and stored for a price of $8.00-$10.00 per cwt. Assuming ¾ (3000 cwt) of the total off-grade product were destined for dehydration, with a 20% loss in pre-processing and 20% dehydration recovery, 48,000 lbs of potato powder could be obtained.

To maintain organic integrity, the USDA NOP (National Organic Program) requires that each facility involved in making the ingredients of an organic product be organically certified. Since HOV currently depends on Master Potato to produce the mash for dehydration, Master potato would also need to become certified organic in order for HOV to have an organic potato powder. This being the case, Master Potato might well consider producing organic mashed potato for food service distribution in addition to providing product for dehydration to HOV.

If a large market for certified organic dehydrated potato becomes evident, certified organic potatoes could be grown specifically for dehydration. New cultivars with high solids are being developed to facilitate high dehydration recovery from field run product. A variety called Altura is said to have solids approaching the 30% level as compared to 18 % for traditional potatoes. This variety appears to be a release from a Western USA breeding program (as per Dr. Thill, U of M potato breeder).

The costs of producing organic potatoes, with a 25% return to labor and management, are approximately $12/ cwt., including storage and delivery to HOV. This is equal to $1,200 per planted acre (Dufner, budget based on 80 acres).

Organic vegetables of all types are currently being grown in the Upper Midwest, but the scale of production is typically small, and prices are typically are high. Most large scale organic vegetable production takes place in California. Large scale production in the Upper Midwest would be possible if a market is secured prior to production. An organic premium of approximately 50% over the price paid for conventional products would be a reasonable price payment guideline, but this could vary significantly depending on the difficulty of growing the product as well as market alternatives.

Honey & Molasses: In addition to vegetables, it was determined that dehydrated honey and molasses may have potential markets and be profitable for Heart of the Valley. Honey has been successfully drum dried by Heart of the Valley using a wheat carrier which serves as a basis for particle formation. HOV's dried honey product was the item which most attracted the attention of organic traders and processors at the All Things Organic food show in Chicago in spring of 2005. It had particular appeal to bakers and manufacturers of natural & organic foods who currently use liquid honey as an ingredient because it was perceived as easier to handle than liquid honey. No one among the food show participants acknowledged having seen dehydrated honey, and interest was genuinely strong. Some of the manufacturers specifically asked about organic honey.

The lowest priced certified organic honey appears to come from Brazil. Hans Friese of Ciranda, Inc. is quoting $1.25/lb for pallet quantities landed in Toronto or the East Coast. A pallet consists of three drums, each containing 617 lbs. net weight of honey. Friese estimates the cost of shipping one pallet from Toronto to be around $400; he provided no estimate on shipping rates from the East Coast, but indicated that if a whole container load were purchased, it could be delivered to the plant for $1.15/ lb.

Louisiana is a major producer of cane sugar and molasses. Most molasses is of the "black strap" quality which is about 38-40% sucrose but very high in salts and best suited for animal feed. Molasses is sold according to the level of brix (a measure of soluble solids) which it contains. The price of 2005 crop is currently around $100 per ton, (approx 45 cents per gallon) the highest level seen in years. A normal price is around $55-$60 dollars per ton. Quality Liquid Feed is the major purchaser of Louisiana's black strap molasses (Legendre).

Edible molasses has a lower level of salts and constitutes about 20% of Louisiana's molasses production. M.A. Pateau & Son has three factories in Louisiana and is the largest single entity in the state dealing in edible molasses. Edible molasses contains about 65% sucrose and it is sold under contract to the baking industry as an ingredient for cookies, etc. The price of molasses appears to be based on its sugar content. If this be true, assuming a sugar price of 21-22 cents per lb., edible molasses should be priced in the neighborhood of $275 per ton in bulk form. There would most probably be additional charges for merchandizing and containerization. Most molasses appear to be shipped by barge, but rail car shipments may be an option. The contact person for M.A.Pateut & Son is Craig Callier (Legendre). Mr. Callier has not responded to phone or e-mail messages, and no price quotes have been forthcoming.

Organic cane sugar and molasses is being produced by Okeelanta Corp of Florida, a division of Florida Crystals. Florida Crystals has a website explaining the sugar making process used by this company (www.floridacrystals.com) but the company has not responded to e-mail inquiries about whether the company would sell organic molasses.

Certified organic molasses from Paraguay could be obtained through Hans Friese of Ciranda, Inc., at Hudson Wisconsin. Ciranda's price quote for organic molasses landed in St. Paul, Minnesota is $.44 per lb.

American Crystal Sugar is the closest local processor of sugar beets, however molasses from sugar beets is not an option as it is sold strictly as cattle feed. American Crystal uses cane molasses to blend with their refined sugar to make brown sugar.

North Dakota is the leading producer of honey, followed by South Dakota (No. 3), and Minnesota (No. 5), so supplies of honey can be obtained in the region. A source of organic honey, however, was not found, therefore supplies must be imported.

Production Costs and Delivered Prices: The crop budgets and/or delivered prices of selected inputs are presented in Table 1. Caution must be taken as commodity prices of many of these products are highly volatile from month to month and season to season.

Table 1. Crop Production Costs & Delivered Prices

Crop & Item	**Production Costs/cwt.**	**Delivered Price/cwt**
Sweet Potato		
No. 1 Grade	$14.50	$22
Canners	$6-10	$13-17
Onion	$5.80	
Carrots	$3.75-4.00	
Organic Potatoes	$12	
Honey	$60-80	
Organic Honey		$115
Molasses	$13-14	
Organic Molasses	$44	

Process Technology and Costs

Process Technology: Research in this area focused on identifying cost effective methods for processing sweet potatoes, corn grits, pumpkin, squash, red beets, sweet corn and honey.

Red Beets: Minnesota Dehydrated Vegetable (MDV) of Fosston MN, in conjunction with AURI of Crookston, ran some dehydration experiments with Red Beets in the 90s, but failed to identify a market for red beet powder. Todd Sissons, AURI's plant manager, was favorably impressed with the Detroit Dark Red variety because of its large roots. Our observation is that the smaller fine-textured Red Ruby variety produces a more intense red color per given unit of product input.

Beets were hand trimmed for the sample run; removing green tops and tap roots. Thereafter they were washed on Hugh's Gardens potato washing equipment, and then further trimmed to remove remaining dirt, and defective portions. The beets were then boiled on a stovetop until soft, hand trimmed to remove root hairs and scaly white tops, and hand-cut into ¾" dice. The diced product was then ground into a puree with a home food processor and placed into 5 gallon pails which were immediately thereafter delivered to HOV for dehydration. For larger scale runs, the prep work could be done at a nearby potato processing facility.

The sample red beet powder was an intense burgundy red color. When placed in a glass of water it did not remain fully suspended; some of the powder settled out to the bottom of the glass. It had a beet taste with also an earthy flavor which might be objectionable if highly concentrated. It would appear to make an excellent food colorant for the natural foods industry.

HOV currently does not have the capability of making a beet puree. It is possible that Master Potato of Hatton could puree beets for a medium sized run, but for large scale production HOV or a cooperator would need to acquire the equipment required to make the puree of beets and other vegetable items, preferably as part of in a continuous line at the HOV facility.

Recent contact with Minnesota Dehydrated Vegetable (MDV) of Fosston reveals that their dehydrator is currently not producing or selling beet powder. Red Beets in the past were grown under contract for MDV and made into powder at MDV by grinding dried beet pieces. Dehydrates Inc of New York was a buyer of beet powder (Karla, inventory control, MDV)

Steve Reich, broker for Dehydrates Inc. (516-293-3700) indicated that beet powder is a rather inexpensive commodity. Dehydrates Inc currently imports beet powder by the container load at a price in the neighborhood of $.75/lb. He suggests that his company would need to get it at a price between 60-70 cents/lb in order to change supplier. Beet

powder would be prized for its deep purple color; lighter pink coloration is less desirable. Beet powder should be fine enough to pass through a # 60 mesh screen, or better yet a #80 screen.

Sweet Potatoes: Heart of the Valley and Master Potato collaborated on a full-scale text run on sweet potatoes. Master Potato obtained 40,000 lb. truckload of cull sweet potatoes and shipped these to Hatton, ND for processing. The delivered sweet potatoes were hand picked and trimmed to remove spoiled product. The product was run through an abrasive peeler, then run through the blancher-cooker, riced and pumped into 270 gallon polyethylene wet totes. The cooked product was then transported to Heart of the Valley for drying. A net yield of 25,000 pounds was shipped to Heart of the Valley, indicating a loss of approximately 15,000 pounds in the inspection, peeling and cooking process, for a shrinkage rate of 37.5%.

The test run procedures were developed jointly by Kim Nesvig of Heart of the Valley and Doug Bumgartner of Master Potato. The target was a puree comparable to commercially available type, with a dissolved solids content of around 15-17%.

The first test run converted 520 lbs of sweet potatoes with a dry matter content of about 88.4# at 17% solids, into 80 lbs of product at 6% moisture. So, the test run recovered approximately 85% of the initial dry matter.

In the second test run, 1000 pounds of sweet potatoes were processed with a dry matter content of 170 pounds. However, in an attempt to increase the net yield, the step of abrasive peeling was eliminated. As a result, the total weight of product recovered was increased to better than 90% of initial dry matter, however several problems occurred. The sweet potato peel tended to plug the ricer screens, slowing down production rates. Second, the cooked peel had a darker color and undesirable coarse texture that persisted in the dried product. The product had to be sifted through a 40 mesh screen to remove this material. The drum drying yielded approximately 3,000 pounds of product at 5-6% moisture, representing approximately a 12% yield from the cooked product.

Several problems were encountered during the drying process. The cooked sweet potato puree, which was near boiling when pumped into the wet totes, tended to thicken considerably as it stood, even though it consisted of only about 12% solids. Additional water was added to make the product flow through the pump to the dryer. The further reduced solids content greatly reduced the hourly product yield and slowed overall processing time. As a result, much of the product stood for period of hours. During this time, bacteria not killed in the blanching process, caused fermentation and spoilage. As a result, at least 8,000 pounds of puree was discarded as unusable.

The results of this full scale test, suggest several problems with the processes for grading, handling, cooking and drying. First, the cull sweet potatoes had an unacceptably high number of unusable products. To avoid this, the product should be more rigorously prior to shipping, and unacceptably high percentage of spoiled product should result in the rejection of the load. Second, abrasive peeling exacerbated high losses. A mechanized

process, such as the Landsekamp peeler, should be adopted for the removal of skins prior to cooking. Third, the product must be held at a temperature sufficient to kill bacteria so that the product will not spoil while waiting for drum drying. Finally, the process must minimize the time that elapses between cooking and drying, so that the product does thicken or ferment while waiting for drying. Further research will be conducted to determine if the process of cooking at Master Potato and drying at Heart of the Valley can be adjusted to address these concerns.

Overall, the sweet potato test runs yielded very good quality finished product, with high sugar content and excellent color. Samples of sweet potato powder have been distributed through a broker network to prepared food and snack food manufacturers. As a result, Heart of the Valley and Master Potato are developing a joint venture for the production of this product. Relationships are being developed with growers in the South to obtain competitive sources of supply for cull sweet potatoes.

Pumpkin & Squash: Heart of the Valley LLC conducted a small-scale test to produce sample quantities of squash. About 500 lbs of squash were obtained for the tests.

In commercial production, whole vegetables are often pureed and cooked through a device therminuator, basically a stainless hammer mill with steam injection. The cooked puree would then be passed through a Langsenkamp paddle separator, which can separate pulp from seeds, skin and other fibrous material. Typically, canners used a lighter skinned squash for both canned pumpkin and baby food applications. The locally grown squash are of the dark-green skinned butternut variety. So, for the purposes of a test run, skins, stem and seeds were removed manually.

Onions: Onions are noted for making a powerful stench when dehydrated, so much so that onion dehydrators sometimes use their plants only for onions. Dehydrated onions are currently sold in a minced and powdered form*;* minced and powdered onions are made from whole dried pieces which are then ground. It is not known whether onions can be successfully dried on drums. Pre-processing equipment would be required to make them into slurry prior to dehydrating them. Dehydrates Inc. indicates a market price of around $.80 per lb for onion powder derived from California.

Carrots: Todd Sisson, former AURI plant manager, cautioned against dehydrating carrots on drum driers because the carrot sugars may produce a burned taste. This does not seem to be a significant problem, based on HOV's past experience dehydrating other items with high sugar content such as red beets, sweet potatoes, honey and molasses. By keeping the steam pressure at 80 degrees, and given the cooling effect of the water being evaporated from the drum's surface, the drum can be kept cool enough to avoid burning (Nesvig).

The most likely use of carrot powder would be in the baking industry where it would be valued for its bright orange color as well as its flavor and texture it brings to the product.

Getting carrots into puree for a trial run could be accomplished with the help of Master Potato. Coordinated in-house processing would likely be required to achieve an economic scale of operation.

MDV is a potential competitor for dehydrated carrot powder, so little was learned from contacting this company. Drum dried carrot powder would be of a different texture and would likely be more soluble, but it appears there would be a high degree of substitutability between drum dried carrot powder and carrot powder made from carrot pieces. Dehydrates Inc. indicates a current market price for carrot powder to be similar to red beet powder, around $.70 per lb.

White Corn: Heart of the Valley also tested the production of instant corn grits. The processing procedures were differed somewhat from the sweet potato process because the grits are obtained in a milled form that is ready for processing. The steps in the production of instant white corn grits were developed for Heart of the Valley by Dr. David Walsh, PhD. Heart of the Valley conducted commercial sized test runs of instant white corn grits.

An alternate processing method was devised to reduce the period of time that grits were exposed to temperature. Under this method, a small amount of raw grits was processed at higher temperatures, creating a suspension. Larger amounts of raw grits were added to the suspension, just before the product was fed to the drum dryer. This enabled the particle size and consistency desired in the instant product to be maintained. Heart of the Valley scaled up the process for commercial sized test runs. Test results produced acceptable quality instant grits at the initial scale, some difficulty in maintaining acceptable particle size and hydration occurred as larger batch sizes were produced. Basically, the raw grits were being overcooked which broke down the particles. The problem was resolved by lowering the temperature of the product before addition of the raw grits.

The test processing has allowed us to developed production cost information for sweet potato and corn grits. The production cost model derives from known costs of plant operation, combined with raw product costs, handling and cooking costs, as well as product yield estimates for these products.

Sweet Corn: Sweet corn presents a unique challenge. The raw product is available during a very narrow harvest window, usually no more than a few weeks long. To utilize locally grown crop, HOV would need to develop procedures for immediate cooking of the harvested crop, or alternatively, would need to store the harvested sweet corn in a stable manner until drum drying could be scheduled.

Conversations with existing producers of sweet corn puree lead to a surprising revelation. Currently, these producers harvest sweet corn, store it as IQF (individually quick frozen) corn and produce the puree from IQF corn. This suggests that local growers and Heart of the Valley might be well advised to identify packers as both a market for raw sweet corn and a source of IQF corn.

Organic Potatoes & Vegetables: The conventional potato flake industry appears to be highly mature one, characterized by many dehydrators operating on low margins in regions where surplus potato for dehydration can be obtained at minimum prices. Organic dehydrators are few. Willow Wind Farms of Washington formerly bought cull-grade organic potatoes, contracted for their dehydration, and offered certified organic potato flake to the market. Willow Wind has recently discontinued this business, but still has organic potato flake to sell. It is not known who will pick up the void in the organic flake dehydration business which Willow Wind has left behind.

Dehydrated potatoes are typically made from culls and potatoes in excess supply. Russets and whites typically have a higher specific gravity and greater percentage of solids than do reds for which reason they are preferred for dehydration. A typical purchase price for potatoes to be dehydrated is $2.00 per cwt. When culls are dehydrated, hand trimming after peeling is often required to remove the most seriously defective product pieces.

Todd Sissons, who has spent considerable time in potato processing projects, mentioned a project underway to make a Pringles-style pre-formed potato chip using conventional dehydrated potato. The project also contemplates making an organic chip using an organic dehydrated potato flake. Sissons referred investigators to John Smart of Smart & Co Inc. of Grand Forks, a consulting and brokerage firm which does world-wide consulting and has a long history of involvement in the potato dehydration business.

J. Smart believed that he can interest major food distribution chains in carrying organic and conventional pre-formed chips under their own private labels. He has also developed a soybean chip product which could be manufactured using the same equipment as the pre-formed potato. Smart wishes to promote the pre-formed potato chip project and is currently working with the Economic Development office of Detroit Lakes to build a plant at Mahnomen where the chip can be manufactured. If built, the Mahnomen plant, would produce primarily conventional pre-formed chips from potato flakes, but might also produce an organic version of the same product. This might present a dehydration opportunity for HOV.

Smart would ideally like to see a smaller certified organic plant dehydrating potatoes and producing an organic chip, all under one roof. He has a lead on a used potato chip line in Egypt which could be purchased, dismantled, shipped and reassembled for about 25% of the cost of new equipment. He is looking for investors to undertake the project. The cost of the Egyptian equipment would be $500,000 which translates into an estimated $1,000,000 after dismantling shipping and reassembling it in the US. Smart says that new equipment of this kind would cost in the neighborhood of $4,000,000. Smart & Co. Inc. would provide information on plant design, equipment requirements, product formulation, manufacturing processes, & workforce training; but most important of all, would provide entrance into the market place. Smart expressed interested in exploring a

relationship with HOV to add a snack line to its existing facility in order to manufacture the product.

Honey & Molasses: Honey and molasses are relatively simple to process as both are naturally in a puree form.
Honey does require the addition of 30 percent wheat starch to be used as a "carrier". Instant honey powder is currently on the list of products for sale by HOV.

Processing Budgets: Summarized budgets for four typical products are presented in Table One. Due to confidentially preferences of HOV, the detail budgets are available only on direct request.

Table No. 2 Processing Costs for Sweet Potato, Edible Beans, Honey and Molasses, 2005

Product & Item	**Cost/pound**
Sweet Potato (puree)	
Materials	$00.31
Processing	$00.371
Packaging	$00.015
Plant Overhead	$00.02
General Overhead	$00.033
Total	$00.75
Edible Beans (puree)	
Materials	$00.31
Processing	$00.371
Packaging	$00.015
Plant Overhead	$00.02
General Overhead	$00.033
Total	$00.75
Honey	
Materials	$00.58
Processing	$00.27
Packaging	$00.05
Plant Overhead	$00.02
General Overhead	$00.033
Total	$00.953
Molasses	
Materials	$00.58
Processing	$00.27
Packaging	$00.05
Plant Overhead	$00.02
General Overhead	$00.033
Total	$00.953

Processing Equipment: HOV is not set up to fully process vegetables until such time as it acquires the equipment necessary to make vegetables into a puree for drum drying. New equipment is normally expensive, and used equipment is typically difficult to find. AURI at Crookston has dismantled its processing laboratory due to lack of budget, and has put most its equipment into storage. AURI indicates that the complete line of processing equipment is for sale, although a price was not established. There is also some AURI equipment at the University which is being used to support a gluten free pasta project under the direction of Dr. Brent Sorenson. Sorenson indicates that the form fill packaging equipment in his charge could be used to help other companies (such as HOV) to launch their products into the market. Dr. Vince Fritz, a University of Minnesota staff member who is a member of the Midwest Vegetable Processors Association, indicates that the Department of Food Science and Nutrition at the University of Minnesota (612-624-1290) routinely works with food processing equipment of all types and could be a helpful resource in selecting equipment. Roeters Farm Equipment (231-834-7888) of Grant Michigan is another source of used vegetable production and processing equipment (Radke).

Processing Certifications

International Certification Service: International Certification Service of Medina, North Dakota, provided the certification service for HOV. The ICS program meets USDA requirements and European requirements for organic processing. It also facilitates access to the Japanese market. Organic certification is required to enter the organic market place, important for the dehydrated vegetable markets.

The ICS program is accredited by the IFOAM Accreditation Program which is operated by the International Organic Accreditation Services. Annual scrutiny by the accreditation program helps ICS to improve its program, and also provides our clients and their customers with additional security in ICS's program. ICS's program is also accredited to ISO 65 by the USDA to satisfy requirements for import into the European Union. Direct cost of certification was nearly $3,000.

American Institute of Baking Food Safety Audit Certification: Heart of the Valley, LLC, desires to operate as a custom drum drying service provider to customers who are involved in the food manufacturing industry. Several companies that are interested in purchasing food ingredients from Heart of the Valley, LLC, require that all of their suppliers be audited by the American Institute of Baking. Heart of the Valley, LLC, intends to provide audit results to all potential customers. Scoring high on an American Institute of Baking audit will show that Heart of the Valley, LLC, complies with food safety regulations and is committed to providing safe, high quality food ingredients and products to consumers.

Heart of the Valley, LLC, is using the American Institute of Baking Consolidated Standards for Food Safety as its tool to evaluate food safety risks within its operations

and to determine levels of compliance with the criteria in the Standards. These criteria are derived from the following good management principles: The U.S. Federal Food Drug and Cosmetic Act (1938); Good Manufacturing Practices, CFR Title 21, Part 110 (1986); U.S. Military Sanitary Standards; the U.S. Federal Insecticide, Fungicide, and Rodenticide Act; EC Directive 93/43/EEC; UK Food Safety (General Food Hygiene) Regulations 1995 (1995/1763); The UK Food Safety (Temperature Control) Regulations 1995; and Codex Alimentarius Commission Food Hygiene - Basic Texts (1999).

Audits provided by the American Institute of Baking are an educational service and are a proven way to achieve sustainable and consistent standards of food safety. Audits are designed to help prevent product adulteration, reduce customer complaints and adverse publicity, and to eliminate regulatory actions such as product seizures, improvement notices, prohibition notices and corporate liability for non-compliance with food regulations. The food safety audit by the American Institute of Baking is conducted by a professionally trained staff of food safety auditors. Food processors who participate in the in-plant audit program receive a complete examination and technical assistance in all areas that affect product integrity, regulatory exposure and pesticide use. Cost of American Institute of Baking certification was nearly $5,000.

Kosher Certification: Heart of the Valley also has received Kosher certification from UMK Kosher. This certification has appeal in markets where there is a significant population of Jewish or Islamic origin. Dehydrates Inc. of New York requested evidence of HOV's Kosher certification. Cost of Kosher certification was $2,800.

Markets and Marketing

Markets were identified for a wide array of vegetable and fruit purees and their dehydrated counterparts. For example, the French company, Diana Vegatal, offers roller dried flakes and powders of twenty vegetables, such as artichokes, broccoli, carrots, cauliflower, celery, green beans, peas, leeks onions, pumpkin, spinach, sweet corn and turnips. The products are used as natural colors in foods, such as pastas, in dry infant foods, fillings and cereals. Another major supplier of dehydrated vegetables is Van Drunen Farms with operations in Illinois and California. They offer both conventional and organic dehydrated vegetables and fruits. Their operation is vertically integrated from organic farm production to processing. Stahlbush Island Farms of Corvalis, OR also offers a wide array of vegetables and fruits, but in IQF (frozen) or pureed forms.

Price information is more difficult to obtain, since vendors are understandably reluctant to share their prices with potential competitors. However, working through broker and distributors we have been able to obtain a limited amount of price information for some vegetable purees and powders.

The research indicates certain areas where opportunities may exist, but has also helped exclude some crops from consideration. Tomato, for example, grows quite well in the region. However, research suggests that the production of dehydrated tomato powder is predominantly imported from Italy, the Israel and China. Prices for tomato powders are very competitive. Also, the products being imported are either pure tomato powder or tomato powder with a maltodextrin carrier. Neither can be produced on a drum dryer. It is furthermore doubtful that the Upper Midwest could compete with established production areas such as California that already produce tomatoes on a massive scale.

Red beets are a different situation. The most likely use for dehydrated red beet powder would be that of a red food colorant in the natural foods industry. A sample run of red beets by HOV produced a powder of strikingly intense burgundy red color which could be used as a food colorant in a variety of foods and beverages. Despite the high sugar content of beets, there was little detectable burned smell of the beet powder, but there was a slight earthy taste which is inherent in red beets.

Pumpkin and sweet potato powder are also being imported, predominantly from New Zealand and China. However, domestic suppliers also exist and based on price information secured to date, locally derived pumpkin and sweet potato appear to be competitive with imported product in domestic markets. Pumpkin flavored ice cream is being sold in the Fargo area, and pumpkin flavored cappuccino was found in a Crookston gasoline service station. Both products had a distinct pumpkin flavor.

Chicago Food Show Event at the McCormick Center, May 1-3, ‘05

The purpose of attending this event was to identify market opportunities for HOV dehydrated products. This event was an excellent place to introduce HOV products to

a broad base of potential clients, and seemed like the quickest method of evaluating demand for them. The event consisted of five simultaneous shows at one place:

- The All Things Organic Show, focusing on organic foods
- The Fancy Food Show, with 400 exhibitors of specialty foods
- The FMI Show, the supermarket industry's most comprehensive event
- The United Produce Expo & Conference, with 250 exhibitors
- The U.S. Food Export Showcase of American made products ready to export

Samples of existing HOV dehydrated products as well as samples of similar products from other area dehydrators were taken to the show. The products taken to the show were as follows:

HOV drum-dried instant powders: 1. Sweet potato; 2. Red beet; 3. Honey; 4. Pinto bean; 5. Navy bean; 6. Black bean; 7. Red bean; 8. Garbanzo bean; and 9. Soybean. Dehydrated carrot and potato, which are potential products for HOV, were not available.

Samples of other food items were obtained other area dehydrators. RDO Foods of East Grand Forks supplied: 1. Instant potato flakes; and 2. Instant potato flake powder. MDV (Minnesota Dehydrated Vegetables) of Fosston supplied: 1. 3/8" cubed potato non-sulfited (darker - beige & tan in color); 2. 1/4" cubed potato sulfited (lighter - beige color); 3. Crushed potato sulfited (still lighter - cream color); 4. 3/8" puffed carrot flake non-sulfited; 5. 1/4" puffed carrot cube, non-sulfited; 6. 40 carrot granules, non-sulfited; and 7. 3/16" cross cut carrot, sulfited

Evaluation of the Demand based on the Chicago Show:
1. Instant honey powder. This was the item that most caught the attention of businesses and aroused the greatest amount of interest. It was particularly interesting to organic bakers and manufacturers of health food bars and snacks, because they perceived it as being easier to use than liquid honey. Liquid honey is messy, difficult to measure, and needs to be stored at a constant temperature in order for it to be properly measured & dispensed. Having a standardized, dried honey formulation which is easily measured, is not messy, and can be conveniently stored was perceived as a definite advantage to the bakers. Although conventional honey is an excellent natural food ingredient, using it together with other organic ingredients may disqualify the final product from bearing the USDA organic seal if the total non-organic ingredients are greater than 5%. A certified organic honey may need to be used in order for the final product to be certified organic and bear the USDA organic label. All else being equal, a certified organic product bearing a USDA logo will normally command a significant market premium over a natural food product made with certified organic ingredients. The market for dried honey appears to be largely untapped and waiting to be discovered, since bakers were interested in it, but do not know where to get this product. North Dakota is one of the leading honey producing states in our nation, and produces a highly desirable honey from bees fed on sweet clover. A source of certified organic honey has not yet been identified, but it is

probably available somewhere in the nation, or at least on the North American continent. One source indicated that Brazilian organic honey can be landed at a port in New Jersey for $.95 per lb. which sounds like an unbeatable price. Sources of supply and demand need to be further explored.

2. Instant red beet powder: This powder is an intense burgundy red, and could serve as a wonderful natural food colorant. It was noted at the HOV plant, however, that it did not stay in suspension after mixing it in water, but rather floated to the top separating into pulp and water. It has a rather earthy taste which could make it objectionable if consumed by itself or as a large percentage ingredient. There might be an issue with the red beet color which passes through the human digestive system.

The most frequent question at the show was: "What can it be used for?" It can be used a natural food colorant, and to enhance the nutritional content of food. Without making claims to expertise in nutrition, baking or food technology, it believed that an instant red beet powder would be a useful ingredient for the natural foods industry to give color and add nutrition to fruit and vegetable juices, and for frostings, ice cream, yogurt or for any other baking needs where red color is desirable. It may also be used as an ingredient for soup base or for making borsht (a Russian red beet soup). No specific buyers for this product were identified, but potential buyers in the organic yogurt and ice cream business seemed somewhat interested. Potential buyers include bakeries, and manufacturers of frozen or chilled dairy products, vegetable drinks, and soups.

3. Instant sweet potato powder: Bakers were interested in this product to use as an ingredient in cookies and cakes. The product's deep yellow color, its texture and its flavor seemed to be the qualities that attracted them. Bakers appeared comfortable with the idea of using it as an ingredient. The vitamin A content of sweet potato may also make it an attractive ingredient for a health conscious market.

4. Instant soybean powder: This product attracted interest as an ingredient for baking and health foods. Organic soybean trading companies appeared to have particular interest in it for its multiple potential uses, and also due to the fact that it can be made from off-grade soybeans. The soybean's high protein content, its growing recognition as a health food and its extensive use as an ingredient in wide array of manufacture food products, all suggest a prominent future for instant soybean powder. The dehydrated product's instant solubility gives it an edge over non-dehydrated soybean flour which does not readily dissolve.

5. Instant edible bean powders: A moderate level of interest was apparent for these products. The black bean and garbanzo bean powders attracted the most attention, followed by red bean powder and pinto bean powder, with white bean powder attracting the least attention, probably because of the respective colors of each. Companies showing interest appeared to consider using bean powder in baking to enhance the nutritive value of wheat, to use as a soup base, and to make dips of various kinds (especially in the case of garbanzo bean powder).

Summary of Demand Evaluation: All of the HOV products were well received, with honey powder capturing the most attention. Product texture, nutritive value, and also color seem to be major factors determining product desirability. Business cards were collected from 59 companies were collected on this trip; many of which are positive trade leads for HOV.

Among firms specializing in natural foods, most would like to see certified organic versions of the HOV products. There is a significant swing in consumer preferences toward what can be considered "natural," which generally means foods which are largely intact with a low level of processing. The move toward organic foods, which are produced in an environmentally friendly manner using naturally occurring inputs and no synthetic ingredients, is part of this shift. In the USA, organic certification is required in order to legally label a product as "organic." Certified organic products command a significant market premium over products made simply with natural ingredients; normally from 20% to100%, and usually around 50% more.

To capture this premium, processors must be certified by a third-party organic certifier accredited by the USDA NOP (National Organic Program) to offer certification. Organic certification requires rigorous documentation including plant layout and handling procedures; daily documentation of plant activities; identity preservation of products with adequate evidence of separation of organic from non-organic products before, during and after processing; appropriate labeling of the finished products manufactured; and an audit trail sufficient to document and preserve the product's organic integrity from the grower to the consumer. Processing aids, inputs and procedures must be approved by the organic certifier as per the NOP guidelines. Organic certification of processed products also involves verifying the percentage of organic ingredients used to make them. If a product is "100% organic" it may bear the USDA seal and the seal of the certifier, with no need to label as "organic" each ingredient. Products which are 95-100% organic, may carry the USDA seal on the front panel of the package, must identify the name of the certifier, and also label which ingredients are organic. Processed products containing at less than 95% but more than 75% organic ingredients may not bear the USDA seal, but can claim to be "Made with organic ingredients" on the front panel, and provide the name the organic certifier on the information panel, as well as identify the organic ingredients on the ingredient statement. Products made with less than 75% organic ingredients cannot make any reference to organic content on the display panel but may state the percentage of organic ingredients on the information panel, in which case the organic ingredients must be identified as such in the ingredient statement.

If the finished products are to be sold abroad, they may need to comply with the organic laws of the importing countries, which can be at variance with the NOP law. In this case, it may be advantageous to choose a certifier accredited to authorize certification not only in the name of the NOP, but also in accordance with other standards, such as IFOAM (International), EU (European Union), JAS (Japanese), Bio Suisse, Quebec, etc. The basics of these programs are similar, but there are some

unique differences, which are best known to those who specialize in organic certification. International certifiers typically add a small fee for each additional certification granted.

Literature Review and Internet Searches:

The dehydrated food industry is a rapidly growing industry in United States. As the data in Table 3 indicate, the value added by the dehydrated establishments increase by 122% from 1997 to 2002. These data infer that the demand for dehydrated foods is increasing rapidly and also that the industry is growing both in number and in size of establishments.

Table 3 Dried and Dehydrated Food Manufacturing, 1997, 2002

	1997	2002	Percent Increase
Number of Establishments	154	181	18
Value Added	$1.339m	$2.971m	122
Number of Est. in Calif & Idaho	68	79	16
Value Added in Calif & Idaho	$0.884m	$1.516m	71
Number of Est. <100 employees	109	139	
Number of Est. >100 employees	44	42	

Source: Dried and Dehydrated Food Manufacturing, U. S. Department of Commerce, Economic and Statistics Administration,
Census Bureau, 1997, 2002

United States is a major import of dehydrated vegetables with negative balance of payments by a factor of 5-6 times each year from 2000 to 2003, the last year data was available. The negative balance has been increasing steadily over this time period.

Table 4 Dehydrated Vegetable Exports and Imports, United States

	2003	**2002**	**2001**	**2000**
Imports	**$1.039m**	**$0.941m**	**$0.904**	**$0.874**
Exports	**$0.128m**	**$0.128**	**$0.133**	**$0.130**
Net Imports	**$0.911m**	**$0.813m**	**$0.771m**	**$0.744m**

Source: http://fao.org/es/ess/toptrade/trade.asp

Even though United States has a major negative balance of payments, there are several countries that U.S. has a positive balance (Table 5). In general, we import from less developed countries and export primarily to European countries. Table 3 indicates there are opportunities to enter the export market. More research is needed on specific products which are exported, and contacts need to be made with exporting firms.

Table 5 Balance of Payments in Dehydrated Vegetables, United States, 2005

Major Negative Balance: Argentina, Chile, China, France, India, Philippines, Poland, South Africa, Turkey

Major Positive Balance: Australia, Belgium, Canada, Denmark, Germany, Japan, Mexico, Netherlands, Sweden, United Kingdom

Source: http://www.census.gov/foreign-trade /statistics/product/naics/naicsctry/balance/b311423.html

There is a large quantity of literature available on dehydrated products in both public research studies and private promotional materials. The focus of research activity has been to search for, read and study, and categorize these sources of information. A matrix of source/product categories versus foci of the information is being developed. This matrix will assist in selection of the most viable source/products for further study, analysis and possible test marketing. Given the relatively low cost for transportation of partially processed product, the origin of included products has been expanded to beyond North Dakota/Northwestern Minnesota. Items which are ranked 4 or 5 will be summarized for further analysis (Table 6).

Table 6. Information about Dehydrated Sources/Products

Source/Products	ID*	P/C**	Type of Use	Potential for HOV***
Regional-Vegetables				
asparagus	1	P	food ingredient	4
-Fruits				
-Other				
National-Vegetable				
-Fruits				
orange peel	2	P/C	color enhancement of juice	2
-Other				
fruit puree	3	P	cold extraction of fruit puree	3
Imports-Vegetable				
-Fruits				
-Other	4	P	India Examines the dehyd. Industry	1
Exports-Vegetable				
-Fruits				
-Other	5	C	Italy Examines Italian retail market for various purees and powders	3

*Identification of information source
**Production focus or consumption focus

*** One to five ranking, 5=excellent, 1=poor

Contact Information:
1. Journal article; Dehydration of low-grade asparagus, in Drying-Technology, 1994, 12(4):903-921.
2. Patent; Method of making flavedo powder for enhancement of orange juice and Jour products thereof; 2002; McArdle, R N; Letourneau, S A; US 2002/0127312 Al
3. Journal article; Cold Extraction of fruit puree, in Fruit-Processing, 2002, 12(5):218-233.
4. Journal article; Dehydration industry in India: status and constraints, in Indian Food-Packer, 1998, (52(5):40-41.
5. Journal article; The Italian Market for sauces, dressing and condiments; in Market Research Europe, 2000, 32(9): 59-105.

There are multiple websites offering dehydrated products, including powders. Some of sites are based in the United States, but several are based overseas. Many of the sites offer both consumer ready food, and ingredients for food manufacturers (Table 7.). The site listed as No. 8, AAOOB Storable Foods, lists HOV products and prices for sale in 52 pound bags.

Table 7. Businesses Offering Dehydrated Products for Sale

Country	ID	Specialization	Products Offered
U.S	1	Organics	Wide variety of fruits, vegetables & grains
U.S.	2	Organics	Wide variety of fruits, vegetables & nuts
U.S.	3.	Internet retailers	Wide variety of fruits, vegetables, & animal products
India	4.	Internet wholesalers	Carrot powders & other vegetables/spices
U.S.	5.	cosmetics	Aloe Vera gel powders
India	6.	Internet wholesaler/ retailer	Dehydrated vegetables
U.S.	7	Internet wholesaler/ retailer	Multiple Dehydrated products
U.S.	8	Internet wholesaler/ retailer	Multiple Dehydrated products
U.S.	9	Internet wholesaler/ retailer	Multiple Dehydrated products
U.S.	10	Internet retailer	Multiple Dehydrated products
International	11.	Internet wholesaler/ retailer	Multiple Dehydrated products

Contact Information:
1. OjaiOrganics: Ingredients@OjaiOrganics.com; Ph:805-646-5759; Fax:805-646-3090; Box 1829, Ojai, California 93024
2. Global Organics: http://www.globalorganicsltd.com/products; Ph: 781-648-8844; Fax: 781-648-0774; Box 272, Arlington, MA 02476-0003

3. Best Prices Storable Foods: http://www.internet-grocer.net; Ph: 972-288-0262; Fax: 903-356-6233; Box 3182, Quinlan, Texas 75474
4. Alibaba: http://www.alibaba.com;
5. Garuda International, Inc.: http://www.garudiant.com/product; Ph: +1 559-594-4380; Fax: +1 559-594-4689; Box 44380, Lemon Cove, CA 93244
6. IndianIndustry.com, directory of Indian companies engaged in manufacturing and trade of dehydrated vegetables; http://www.indianindustry.com
7. Walton Feed, http:www.
8. AAOOB Storable Foods; http://www.aaoobfoods.com/bulkfoods.htm#Specialty%20Flours, this site lists HOV products as a new line of specialty flours: Pinto Bean Powder($68.85/52lb. bag), Navy Bean Powder($53.33/52lb bag), Black Turtle Bean Powder($58.73/52lb bag), Red Bean Powder($61.43/52lb bag), Garbanzo Bean Powder($62.78/52lb bag), Honey Powder($91.13/52lb bag), Sweet Potato Powder($203.18/52lb bag)
9. the Food Source, inc.; http://www.foodsourceinc.com/vegetables.html; this site contains a very large number of vegetables in various dehydrated forms
10. Internet Grocer; http://www.internet-grocer.net/dehydrtd.htm; contains a large variety of dehydrated products for retail sale.
11. Oceanic Foods Ingredients & Spices Put., Ltd; http://www.oceanicdehydrates.com/products.htm,

Some Internet sites offer primarily consumer ready finished dehydrated foods(Table 8). These have been separated from those dealing primarily in bulk products. They obviously obtain their dehydrated inputs from the market and could be potential customers for HOV.

Table 8. Businesses Interested in Buying and/or Selling Dehydrated Products

Country	ID	Specialization	Products Required
U.S.	1	Dehydrated Foods	Multiple dehyd. materials
U.S.	2.	Dehydrated Foods	Multiple dehyd. materials
U.S.	3	Dehydrated health foods	Multiple dehyd. materials
U.S.	4	AgriSeek	Multiple dehyd. materials
International	5.	TradeKey	Multiple dehyd. materials
International	6.	Alibaba	Multiple dehyd. materials
U.S.	7	20un	Multiple dehyd. materials

Contact Information

1. Emergency Essentials, http: //www. emergencyessentials.com
2. Galloway Specialty Foods, http://www.gallowaysfoods.com/veg
3. NexTag, http://www.nextag.com/buyer, NexTag supplies a wide variety of natural and organic vegetable protein powders.
4. AgriSeek, http://www.agriseek.com/buy-sell/e/Ag-Products/Dehydrated Vegetables/, dehydrated products are bought and sold over this Internet webpage.
5. TradeKey,
6. Alibaba, http://www.alibaba.com/
7. 20un, http://www.20un.com, an Internet webpage for buying/selling food products

Conclusions by Objective

Vegetable Production and Input Supply: The primary input supply problem is not the potential to produce vegetables at relatively low cost in the region, but the fact that very little production currently exists. This means farmers must enter an industry where they have gain knowledge quickly on production techniques, invest in the necessary specialized equipment, and possibly construct storage facilities. Each of these steps requires substantial investment in the face of an uncertain market. Recent history with carrot production and processing, three processing cooperatives were started and failed in the region, has led to increased caution in jumping in to new ventures.

Processing Technology and Costs: Heart of the Valley has processed small quantities of a wide variety of vegetables without major problems except for sweet potatoes. The processing problem with sweet potatoes can be overcome with the proper equipment. However, HOV currently requires that the input product is in puree form. Currently this is a problem with processing of regionally produced vegetables and would require additional investment to acquire the necessary equipment.

Markets and Marketing: The market for dehydrated products is a highly competitive one. It is a market characterized by numerous firms marketing relatively homogenous products which can be transported over long distances at a relatively low cost. In this type of market, the more efficient, low-cost producers tend to prosper; while the less efficient, higher-cost producers find themselves unable to compete. The relatively long shelf life of dehydrated products permits them to be stored from season to season, and further adds a temporal dimension to the competitive nature of this market.

To succeed under these market conditions, firms typically tend to do one or more of the following:

1) Attract customers through better service, lower prices or better terms of payment.
2) Expand production & modernize to achieve economies of scale.
3) Develop forward contracts to ensure low cost supplies and profitable sales.
4) Differentiate products so as to distinguish them for their advantages, either innate or perceived.
5) Make the products more attractive and easier to use through packaging, recipes, and utilization counseling.
6) Identify market niches for products which permit profitable margins.
7) Produce specialty products which permit profitable margins
8) Integrate vertically with suppliers to ensure input supplies, and with buyers to ensure sales.

The primary conclusions of the markets and marketing effort are: 1. The same factors that make an isolated area such as North Dakota a favorable location for dehydration, major

reductions in transportation and storage costs, also lead to a large number of competitors in the industry, domestic and international; 2. development of an appropriate marketing strategy and the financial and human resources to implement the strategy will be a key to successfully competing in these markets.

Conclusions by Input/Product

Red Beets

Red beets are easily grown, harvested and stored in the region. They dehydrate into a intense burgundy red color which has potential value in the processing industry as a food colorant. Two potential problems were noted: 1. test runs yielded a powder that did not remain fully suspended; 2. the color passes through the human digestive tract. There is a market for the product, but the market prices are not high.

Sweet Potato

Test and small commercial scale runs of sweet potato powder was conducted jointly by Master Potato of Hatton, ND and Heart of the Valley LLC. Costs of producing commercial scale quantities of sweet potato were developed. It appears that by operating jointly, Master Potato and Heart of the Valley LLC can produce competitively priced sweet potato puree and powder. For example, sweet potato puree available FOB Oregon, sells at approximately $45/cwt. Master Potato was able to produce the puree for a sales price of $35/cwt. Further economies may be achieved at larger scales of production.

Further economies in the production of sweet potato powder might be achieved by handling and cooking raw sweet potatoes at the Heart of the Valley facility. However, since the plant is not presently equipped to receive, store and clean raw vegetables, this step would require considerable capital expense and is not deemed feasible at this time.

The region has very limited potential for local production of sweet potato. An organic producer in La Crosse, WI is able to sustain the warm weather variety by sheltering the plant from cool night temperatures. While this may be cost effective for modest production of organic sweet potatoes, larger volume production using these methods would be intensely labor intensive. In our judgment, Heart of the Valley would be well advised to cultivate supply relationships with growers in traditional growing states for this product.

Pumpkin & Squash

Commercial pumpkin production is technically feasible in the region. Locally produced pumpkin can be secured at a lower delivered cost per pound than sweet potato, but the raw product requires more manual labor (removing seeds & stems) prior to cooking, and raw pumpkin has a comparatively short storage life.

Commercial scale production of puree would require improved raw storage capability, a prompt conversion of raw product to puree, and freezing of the puree for sale and production of powders. The methods currently used by Master Potato to produce

unfrozen mashed potato are directly applicable to the production of pumpkin puree. However, the facility lacks freezing capacity. Collaboration with the IQF freezing facility in Leeds, ND might offer a mechanism for achieving long term storage of pumpkin puree.

Onion & Carrots

Both these vegetables can and are being grown in the region. Given a market at a profitable price, production could increase substantially. Both vegetables require that HOV add processing equipment to their operation to make puree, or contract with a local processor. There is an established market for onion and carrot powders, which is positive on one-hand and negative on the other. The major feasibility question with onions and carrots is that there is strong domestic and international competition established in the market.

White Corn

Test production at Heart of the Valley LLC demonstrated that the plant could produce an instant white grit identical to commercially available products. At present, all available varieties of white corn have maturities in excess of 92 days. The major growing areas are Nebraska and Kansas. While there is ongoing research to develop earlier maturation varieties, these are unlikely to be available for several years. While it appears that the Heart of the Valley plant can produce an acceptable white grit at a competitive price, the region lacks a facility capable of milling white corn and capability of marketing the corn milling by products. This could pose an obstacle to local production of white corn even if a shorter maturity variety is developed.

Sweet Corn

A small market opportunity exists for sweet corn puree and powder in both Europe and Asia. However, production in the region poses some challenges. The raw product is available during a very narrow harvest window, usually no more than a few weeks long. To utilize locally grown crop, the Company would need to develop capacity and procedures for immediate cooking of the harvested crop, or alternatively, would need to store the harvested sweet corn in a stable manner until drum drying could be scheduled. A more feasible method, in the short term, would be to procure Individually Quick-Frozen (IQF) sweet corn for existing packers in southern Minnesota. A processing plant in Leeds, ND has IQF capability, and may represent a future opportunity for the local production of sweet corn.

Organic Potatoes and Vegetables

Organic products represent a small but potentially attractive niche for local growers and processing facilities. Generally, organic products command a significant premium in the market place, which in turn makes smaller scale production more feasible. Organic production of pumpkins, sweet corn, sweet potato, beets and edible beans could provide a viable base for expanding vegetable production in the region and support the production of both vegetable purees and powders.

As a result of this project, Heart of the Valley is a certified organic processor, and has developed marketing arrangements with SK Foods of Fargo, ND to pursue the marketing of organic edible bean powders. This avenue is generating increasing volumes of sales each month. However, due to proprietary issues, specific details of production and marketing are being withheld from this report.

Organic honey powder also appears to have considerable potential. The raw organic honey is available at a price that is comparable to conventional dark amber honey, and yields from drum drying would be identical. Some additional research is needed to identify sources of organic, non-GMO variants of the refined rice starch required in the drum drying process.

Honey & Molasses

North Dakota ranks as the nation's largest producer of liquid honey. Commercial markets exist for powdered honey. However, honey cannot be dried without amendment. Honey powder is produced in two ways: 1) a drum dried product utilizing refined starch (wheat or rice) as a carrier, or 2) a spray dried honey powder that uses maltodextrin as the carrier. Heart of the Valley conducted successful, commercial scale production of honey powders at both the 70% and 40% blends (the latter includes hi-fructose corn syrup). It appears that Heart of the Valley can be cost competitive in the production of honey powders.

Most customers for honey powder specify a product made from Dark Amber honey. North Dakota, however, is known primarily for the production of premium light clover honey. Consequently, the production of honey powder would require that supplies of darker, lower cost honey grades from other regions, primarily Texas and California. Many North Dakota honey producers also transport hives to southern states for winter, and others have working relationships with southern producers, so the supply of dark amber honey may still benefit North Dakota based producers.

Summary of Conclusions

The ability of a dehydrator to produce a finished product competitively depends largely on the firm's ability to source its inputs at a low price. HOV has the unique advantage of being situated in the heart of the Red River Valley which has highly fertile soils and can produce a wide variety of crops at very competitive prices. This being the case, HOV has range of alternative products which it can potentially dehydrate. Edible bean splits, which were envisioned to be the basis of HOV operations, are in abundant supply; as are soybeans splits, split peas and an array of grains. Presently, more profitable alternatives are being sought for HOV's product mix. Vegetable crops present alternatives. Potatoes are by far the most widely vegetable abundant vegetable in the Red River Valley, but other large potato dehydrators already operate here as well as in Idaho and other low cost production regions. This market appears saturated. Several other vegetable crops can be competitively grown here, but, except for potatoes, large scale vegetable production has not taken place due to the short growing season, the perishable nature of most harvested vegetables, the lack of a nearby major metropolitan market, and the absence of facilities

to process vegetables into a shelf-stable form. Dehydration may represent such an alternative.

The bottom line is that successful expansion of Heart of Valley into vegetable processing based on regional production requires several factors to occur simultaneously. Farmers must invest to produce and store new crops, HOV make additional investments to accept raw vegetables and process to the puree form, and reliable profitable markets must be found in a very competitive industry. The probability of each of these events occurring is less than 100 and the joint probability substantially less. It will take time and investment funds in order for HOV to be successful. Starting the process with imported (to the region) puree eliminates two of the barriers and clearly is the best strategy to adopt. This leaves only the challenge of obtaining reliable markets for their product, in itself a difficult task considering the competitiveness in the market from domestic and international suppliers. Regional production can be incorporated over time and when the market uncertainty is reduced.

Suggestions for Further Research

Production, processing and marketing research is a continually process for a successful business. It is a very dynamic industry. For Heart of the Valley, a major limitation is the lack of equipment to produce puree on a competitive, commercial basis. The methods, equipment and cost of making vegetable puree needs to determined. The most direct manner of doing this would be to obtain the assistance of someone familiar with vegetable processing who could define the processes required and specify the equipment needed. Price per unit processed puree could be determined based on the cost of the equipment, the labor to operate it, and the volume which it can handle. An Instant Quick Freeze Plant (designed for freezing individual vegetable pieces) may not be of help in storing a pumpkin puree. A vegetable product could rather be chopped, frozen and stored by an IQF facility and then pureed and dehydrated when needed. Research on the process, length of storage and the costs of this alternative is needed.

A second major area of research is the continual process of finding that "market niche" which HOV could be a major supplier. HOV currently has limited capacity and would have problems competing in large markets which are currently being served by strong domestic and international competitors. It needs to find a number of "market niches" to provide diversified revenue flows. This has not been fully accomplished at this time.

Current & Future Benefits of the Project

As a result of this project, Heart of the Valley is a certified organic processor, and has developed marketing arrangements with SK Foods of Casselton, ND to pursue the marketing of organic edible bean powders. This avenue is generating increasing volumes of sales each month. It also has met the American Institute of Baking Safety Audit Certification requirements for food safety and quality. This will assist HOV in entering the bakery market.

HOV is currently in the market with seven products being advertised on the Internet (http://www.aaoobfoods.com/bulkfoods.htm#Specialty%20Flours). These products are:

1. Instant Pinto Bean Powder
2. Instant Navy Bean Powder
3. Instant Black Turtle Bean Powder
4. Instant Red Bean Powder
5. Instant Garbanzo Bean Powder
6. Instant Honey Powder
7. Instant Sweet Potato Powder

Only two of these products were investigated in this project, but it is expected to add additional products in the near future.

Organic and Kosher certification has made possible the following products offered by Heart of the Valley:

Instant Organic Yellow Split Pea Powder/Flakes (HTR-MSHF Pareve)
Instant Organic Green Pea Powder (HSR-HNVD Pareve)
Instant Organic Garbanzo Bean Powder/Flakes (WBR-DBNS Pareve)
Instant Organic Split Pea Powder/Flakes (ZHD-NSFV Pareve)
Instant Organic Dehulled Soybean Powder/Flakes (LHQ-NRBG Pareve)
Instant Organic Soybean Powder/Flakes (CXT-XKSV Pareve)
Instant Organic White Kidney Bean Powder/Flakes (XWP-CLTW Pareve)
Instant Organic Small Red Bean Powder/Flakes (HZC-TWLR Pareve)
Instant Organic Green Lentil Powder/Flakes (JHP-BBPW Pareve)
Instant Organic Great Northern Bean Powder/Flakes (KPS-XZQP Pareve)
Instant Organic Navy Bean Powder/Flakes (GFG-CCJC Pareve)
Instant Organic Azuki Bean Powder/Flakes (SZM-RMCX Pareve)

The project has assisted HOV in conducting sample processing runs of several products not yet marketed. Much has been learned in these processing runs. Substantial knowledge has been gained about the markets for dehydrated powders and the general process of marketing in the industry. These gains have further prepared Heart of the Valley to move forward and be successful as a business and to stimulate economic growth in the region's crop production.

Contribution of Public & Private Cooperators

Heart of the Valley LLC, Portland, ND: Heart of the Valley LLC provided technical skills, labor, raw product and processing facilities required for the conversion of vegetable purees to powders. In addition, Heart of the Valley staff and food ingredient brokers conducted direct market research identifying potential customers, competitors and price information for a wide array of vegetable purees and powders. In total, Heart of the Valley LLC contributed more than $51,000 as in-kind contributions towards this project.

Mid-America Consultants International, Fargo, ND: Two of the project investigators represented MACI, a 35 member consulting company organized as a cooperative.

Master Potato, Hatton, ND: Master Potato provided invaluable support for the project, conducting two small scale production runs of sweet potato puree yielding 1000 pounds of puree, followed by a commercial scale run of 40,000 pounds of puree. The total value of the in kind contributions by Master Potato exceeded $19,000.

SK Foods, Casselton, ND: SK Foods contributed a wide variety of organic dry edible beans and small grains for test production runs. The value of these organic products exceeded $5,000. SK Foods also conducted proprietary market research that helped establish new market opportunities for Heart of the Valley and the region's organic bean and grain producers. SK Food International, Inc., 4749 Amber Valley Parkway SW, Fargo, ND 58104

Agricultural Utilization Research Institute, Crookston, MN: AURI provided substantial advice on processing technology and on some of the products being tested.

Additional Information Available from Heart of the Valley

Detailed Crop Budgets

Detailed Processing Budgets

List of Contacts from Chicago Food Show

Contact Persons:

Dr. William C. Nelson
MACI
P.O. Box 806
Fargo, ND 58107
Bill.Nelson@maci.coop
218-532-5193

Hugh Dufner
MACI
P.O. Box 806
Fargo, ND 58107
HDufner@aol.com
218-291-1000

David Speare, Mgr
Alan Haavig, Office Mgr
Heart of the Valley, LLC
30 Main Street East
Portland, North Dakota 58257
Email: hov@polarcomm.com
701-788-4164

References

1. Dufner, H.J., D.L. Helgeson, S.M. Wulff, G.W. Rourke, and J.T. Golz. 1990. Economic feasibility of vegetable production, marketing, and processing in the Red River Valley of North Dakota. Agr. Econ. Rpt. No. 259, Dept. of Agr. Econ., North Dakota State University, Fargo, ND. 81 pp.

2. Lee, C.W., R.L. Abrahamson, and R.G. Greenland. 1997. Production and marketing of vegetable crops adapted to North Dakota conditions. Dept. of Plant Sciences, North Dakota State University, Fargo, ND. 73 pp.

3. Maynard, D.N. and G.J. Hochmuth. 1997. Knott's handbook for vegetable growers. 4th ed., John Wiley& Sons, Inc., New York. 582 pp.

4. Simon, J.E., M.R. Morales, and W.B. Phippen. 1999. Midwestern vegetable variety trial report. Bul. No. 788. Purdue University Department of Horticulture, West Lafayette, IN. 187 pp.

List of Resource Persons

Name	Institution	Phone	E-mail	Expertise	Product
1. Agronomy	"U of MN, St.Paul, Crop Production	612-625-7773			Agronomy
2. Baumgartner, Doug, potatoes"	"Master Potato, Hatton"				"Processor, "Potato, chilled"
3. Brummund, Brad	"NDSU, Extension"			Extension	Organic Crops
4. Caillier, Craig, charge	M.A.Pateau & Son	337-276-4592			In "Molasses, edible"
5. Chang, Dr. Sam,	"NDSU, Food Technlgy"	701-231-7485, kow.chang@ndsu.nodak.edu,	Food Technology	General	
6. Delahaute, Karen,	"U of Wisc, Madison"	608-262-6429 kadelaha@wisc.edu,	Veg. Specialist	Budgets	
7. DeMuth, Dr. David, Ag.	"U of MN, Crookston"				Sustainable Website
8. Doty, Dr. Neil,	Doty and Associates	701-297-7500 neild@ncdoty.com,	Food Consulting	Food Marketing	
9. Dwight Akkre, Potato	"NDSU, Extension"			Extension	Irrigated
10. Enger, Steve,	Steve Enger Farm	218-779-9917 (cell)			
Producer	Pumpkin & Carrot				
11. Extension,	"U of MN, St.Paul"	612-625-9733			
Extension	Crop Production				

12. Fladeland, Terry, "Master Potato, Hatton" Processor "Potato, chilled"
13. Fonteneau, Larry, Fonteneau Farm 337-360-1370 (cell) Producer/shipper Sweet Potato
14. Fritz, Vince, "U of MN, Extension" 507-835-3620 Extension Food Processing & IQF
15. General, "LA State U., Baton R." 222-578-3202 Southern Crops "Swt Potato,mollases"
16. Gerke, Ed, Food broker 218-847-4758 Food Broker Food Marketing
17. Hatterman-Valenti, Harlene, NDSU Plant Science 701-231-8536 h.hatterman.valenti@ndsu.nodak.edu, Veg Specialist Veggies
18. Hellevang, Dr. Kenneth, "NDSU, Extension" 701-231-7243 kenneth.hellevang@ndsu.nodak.edu, Storage, carrot etc."
19. Hodges, Larry, "U of Neb, Lincoln" 402-472-1639 Horticulture Veggies
20. Horticulture, "U of Wisc, Madison" 608-262-1490 Horticulture Vegetables
21. Horticulture, "U of MN, St.Paul" 612-624-5300 Horticulture Vegetables
22. Hurley, Terry, "U of MN, St.Paul" 612-625-1222 thurley@apec.umn.edu, Applied Econ Crop Budgets
23. Kalagridas, George, Georges Organics GeorgeK@georgesorganics.com, Organic broker Ingredients
24. Labonte, Dr. Don, "LA State U., Baton R." 222-578-1024 Breeder Sweet Potato
25. Lee, Dr. Chiwon, "NDSU, Plant Science" 701-323-8062 chiwon.lee@ndsu.nodak.edu, Horticulture Pumpkin
26. Legendre, Benjamin, LSU Ag Center 225-642-0224 blegendre@agctr.lsu.edu, S.Cane Speacialist "Molasses, sugar"
27. Main Number, "U of Ill, Peoria" 608-233-0460 Nat Resources Pumpkin
28. Malone, Bryce, LA. Swt Pot. Commission 225-933-1234 Mktg Dept Sweet Potato
29. Nienhuis, Dr. Jim, "U of Wisc, Madison" 608-262-1424 nienhuis@wisc.edu, Veg. Specialist "Squash,horseradish"
30. Ninnick, Terry, "U of MN, Crookston" Extension Veggies
31. Noyes, Jim, MN Dehy Veg (MDV) Gen Mngr. Veg Dehydration
32. Olson, Kent, "U of MN, St.Paul" 612-625-7723 kdolson@umn.edu, Applied Econ Crop Budgets
33. Perdomo, Raul, Florida Crystals 561-993-1695, Raul_Perdomo@FloridaCrystals.com, Dir of Reseach, Molasses, organic"
34. Radke, Rudy, "NDSU, Extension" 701-356-0222 rradke@ndsuext.nodak.edu, Extension High Value Crops
35. Reich, Steven, Dehydrates Inc 516-295-3700 Dehydrates123@hotmail.com, Broker Dehy vegetables
36. Rick Jones, Dehydration 509-787-3535 Plant Mngr Used Dehy Eqpmt
37. Robock, Dr. Matthew, "Mich State, E Lansg" 517-355-5191-1410 ngouajio@msu.edu, Veg. Specialist Vegetables
38. Russ Nestle, 303-705-2224 Sales Org. Pot.Flake
39. Ryan, Dr. Peter, Audubon Sugar Institute 225-642-0135 prein@agcntr.lsu.edu, Dept. Head "Molasses, sugar"
40. Seaver, Derrick, Minnesota Bean & Pea Business Owner Used AURI Eqpmt

41. Shiloh Farms, Shiloh Farms Website
"Potatoes,dehy,organic "
42. Sissons, Todd, Native Harvest/AURI 218-334-2190 home
Food Processing "Potatoes, veggies,HACCP"
43. Sistrunk, Myrle, LSU Extension Agent 318-428-3571
West Carrol Agent "Molasses, sugar"
44. Smart, John, Smart & Co Inc. 701-780-8182, smartjohn@qwest.net,
"Cnsltnt, Marketer" Potato dehy plants
45. Sorenson, Dr. Brent, "U of MN, Crookston" 218-281-8138
Agribusiness Gluten Free Pasta
46. Stahlbush Farms, Stahlbush Farms Website Veg.
Slurries Sundry
47. Stordahl, Jim, "U of MN, Crookston" Extension
Organic Crops
48. Swenson, Andy, "NDSU, Extension" 701-231-7379
Extension Budgets
49. Tong, Dr. Cindy, "U of MN, St.Paul" 612-624-3419 c-
tong@unm.edu, Post Harvest Veggies & Fruits
50. U of Ill, Urb-Champ, "U of Ill, Urb-Champ" 217-333-1000
General Pumpkin
51. Vegetable Crops Dept., "U of Ill, Peoria" 608-333-1965
Nat Resources Pumpkin
52. Voigt, Chuck, "U of Ill, Urb-Champ" 217-333-1969
Cevoigt@uiuc.edu, Veg. Specialist Pumpkin
53. Wene, Dr. Ed, "AURI, Crookston" 218-281-9014
Microbiologist Used Equipment
54. Wilson, Dr. Paul, LSU Food Science Researcher Sweet
Potato
55. Zandstra, Dr. Bernard, "Mich State, E Lansg" 517-355-5191-1418
Extension Carrot etc.